

Finally, it may be mentioned that these nodules also grow in circumference, by the alveolar septa of the neighbouring alveoli gradually becoming thickened, while, at the same time, the epithelium of the corresponding alveoli undergoes the changes before described. The capillary vessels of these parts show the same changes as were mentioned in the case of the guineapig's lung—being transformed gradually into nucleated fibres, which must be supposed to be, for a certain time, still permeable by coloured fluids.

If we summarize the results thus described, it is evident that the changes in the process of miliary tuberculosis in man are only to a limited extent similar to those which occur in the process of artificial tuberculosis in guineapigs. In the lung of tuberculized guineapigs the first structural changes are characterized, briefly speaking, by the appearance of perivascular lymphangial nodules, whereas the changes of the interalveolar tissue and the alveolar epithelium form only a secondary process. In miliary tuberculosis of man, on the other hand, we see that the first changes take place in the alveoli and interalveolar septa, and these changes are followed by the appearance of perivascular cords.

It is therefore probable that, in artificial tuberculosis of the lung of the guineapig, the parts first attacked are the small branches of the pulmonary artery or pulmonary vein, whereas in the miliary tuberculosis of man the capillary blood-vessels of the alveoli seem to be the tissue from which the action of the morbid agent starts.

II. "On the Comparative Value of certain Geological Ages (or groups of formations) considered as items of Geological Time."
By A. C. RAMSAY, LL.D., V.P.R.S. Received December 16, 1873.

(Abstract.)

The author first reviews briefly several methods by which attempts have been made to estimate the value of minor portions of geological time, such as:—calculations intended to estimate the age of deltas, founded on the annual rate of accumulation of sediments; the astronomical method followed by Mr. Croll, in connexion with the recurrence of glacial epochs; the relative thicknesses of different formations; and the relation of strong unconformity between two sets of formations in connexion with marked disappearance of old genera and species, and the appearance of newer forms. Having shown that none of these methods give any clear help in the absolute measurement of time in years or cycles of years, even when founded on well-established facts, he proceeds to attempt to estimate the *comparative value* of long portions of geological time, all of which are represented by important series of formations.

The author then alludes to the subject of two papers by himself, given to the Geological Society in 1871, on the Red Rocks of England, in which he attempted to show that the Old Red Sandstone, Permian, and New Red series were all deposited in great inland lakes, fresh or salt; and this, taken in connexion with the wide-spreading terrestrial character of much of the Carboniferous series, showed that a great continental age prevailed over much of Europe and in some other regions, from the close of the Silurian epoch to the close of the Trias. He then endeavours to show the *value* of the time occupied in the deposition of the above-named formations, when compared with the time occupied in the deposition of the Cambrian and Silurian strata, and of the marine and freshwater strata which were deposited between the close of the Triassic epoch and the present day.

After alluding to the probable mixed estuarine and marine character of the purple and grey Cambrian rocks of St. David's, it is shown that the Cambrian and Silurian series may be massed into three great groups:—first, from the bottom of the purple Cambrian rocks to the top of the Tremadoc slates; these being succeeded unconformably by the second group, the Llandeilo and Bala or Caradoc beds; on which rest unconformably the members of the third series, ranging from the base of the Upper Llandovery to the top of the Upper Ludlow beds,—each unconformable break in stratigraphical succession being accompanied by a corresponding break in palæontological succession.

These three great divisions are next shown to be comparable, in the time occupied for their deposition, to the three divisions of Lower, Middle, and Upper Devonian rocks, which are considered to be the marine representatives of the Old Red Sandstone; and therefore it follows that *the time occupied in the deposition of the latter may have been as long as that taken in the deposition of the Cambrian and Silurian series.* This position is strengthened by the great palæontological differences in the fossils of the Upper Ludlow and those of the marine Carboniferous series, which seem to indicate a long lapse of time during which, in Old Red Sandstone areas, no direct sequence of marine deposits took place.

The next question considered is, what relation in point of time the deposition of the Old Red Sandstone may have taken, when compared with the time occupied in the deposition of certain members of the Mesozoic formations. Through a series of arguments, lithological, stratigraphical, and palæontological, the conclusion is arrived at, that the whole of the Liassic and Oolitic series present the various phases of one facies of marine life, and, in this respect, are comparable to the changes in the fossil contents of the various subformations of the Cambrian and Lingula-flag series, of which the Tremadoc Slates form an upper member. In like manner the Lias and Oolites may be compared with the Lower Devonian strata; and therefore *a lower portion of the*

Old Red Sandstone may have taken as long for its deposition as the whole of the time occupied in the deposition of the Jurassic series.

Following out this train of argument through the Neocomian and Cretaceous strata, the result is arrived at *that the whole of the time occupied in the deposition of the Old Red Sandstone may have been equal to the whole of the time occupied in the deposition of all the Jurassic, Wealden, and Cretaceous strata collectively.*

In the same manner the next term of the Continental era, the Carboniferous epoch, is compared with the Eocene period, both being locally of marine, estuarine, freshwater, and terrestrial origin, and both connected with special continental epochs. Next comes the Permian series, comparable in its lacustrine origin to the Miocene strata of so much of Europe, though in the case of the Permian waters the lakes were salt. After this the Triassic series of Europe alone remains of the old continent, the marine and salt-lake strata of which are not likely to have taken a shorter time in their deposition than the older Pliocene strata.

If the foregoing method be of value, we arrive at the general conclusion *that the great local continental era, which began with the Old Red Sandstone and closed with the New Red Marl, is comparable, in point of Geological Time, to that occupied in the deposition of the whole of the Mesozoic series later than the New Red Marl, and of all the Cainozoic formations, and, more probably, of all the time that has elapsed since the beginning of the deposition of the Lias down to the present day; and consequently the more modern continental era, which locally began with the Eocene period and lasts to the present day, has been of much shorter duration.*

The author then pointed out that during the older continental era there flourished two typical floras—one extending from the time of the Old Red Sandstone to the close of the Permian strata; while the second, which is largely of Jurassic type, characterized the Triassic formations. From the time of the Lias onward in time, we have also two distinct typical floras—the first of Jurassic, and the second of much more modern type, beginning with the Upper Cretaceous strata of Aix-la-Chapelle and lasting to the present day.

In like manner the faunas connected with the land resolve themselves into two types:—the first chiefly Labyrinthodontian, as shown in the Carboniferous and Permian strata; and the second characteristic of the Trias, with Crocodilia, many land-lizards, Anomodontia, Deinosauria, and Marsupial Mammalia. This fauna, as regards genera, with the exception of Labyrinthodontia and the appearance of Pterosauria, is represented through the remaining members of the Mesozoic formations, from Jurassic to Cretaceous inclusive. After this comes the Pachydermatous Mammalian Eocene fauna, and after that the Miocene land-fauna, which, in its main characters, is of modern type. From Jurassic to Cretaceous times, inclusively, there was therefore, as far as we know, in this area a land-fauna chiefly Reptilian, Saurian, and Marsupial, and

in Tertiary times chiefly Reptilian and Placental. (Illustrated by a Table.)

In conclusion, the recent character of the early marine faunas of the Cambrian and Lingula-flag series was pointed out, such as Spongida, Annelida, Echinodermata, Crustacea, Polyzoa, Brachiopoda, Lamelli-branchiata, Pteropoda, Nucleobranhiata, and Cephalopoda. This was long ago insisted on by Professor Huxley; and we find no evidence of its having lived near the beginning of the zoological series; for below the Cambrian series we are at once involved in a sort of chaos of metamorphic strata. Of the geological history, in the words of Darwin, "we possess the last volume alone, relating only to two or three countries." The connexion of this question with that of the comparative value of different geological eras is obvious, especially in relation to the palæontological part of the question.

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